AGRICULTURAL Research

U.S. DEPARTMENT OF AGRICULTURE

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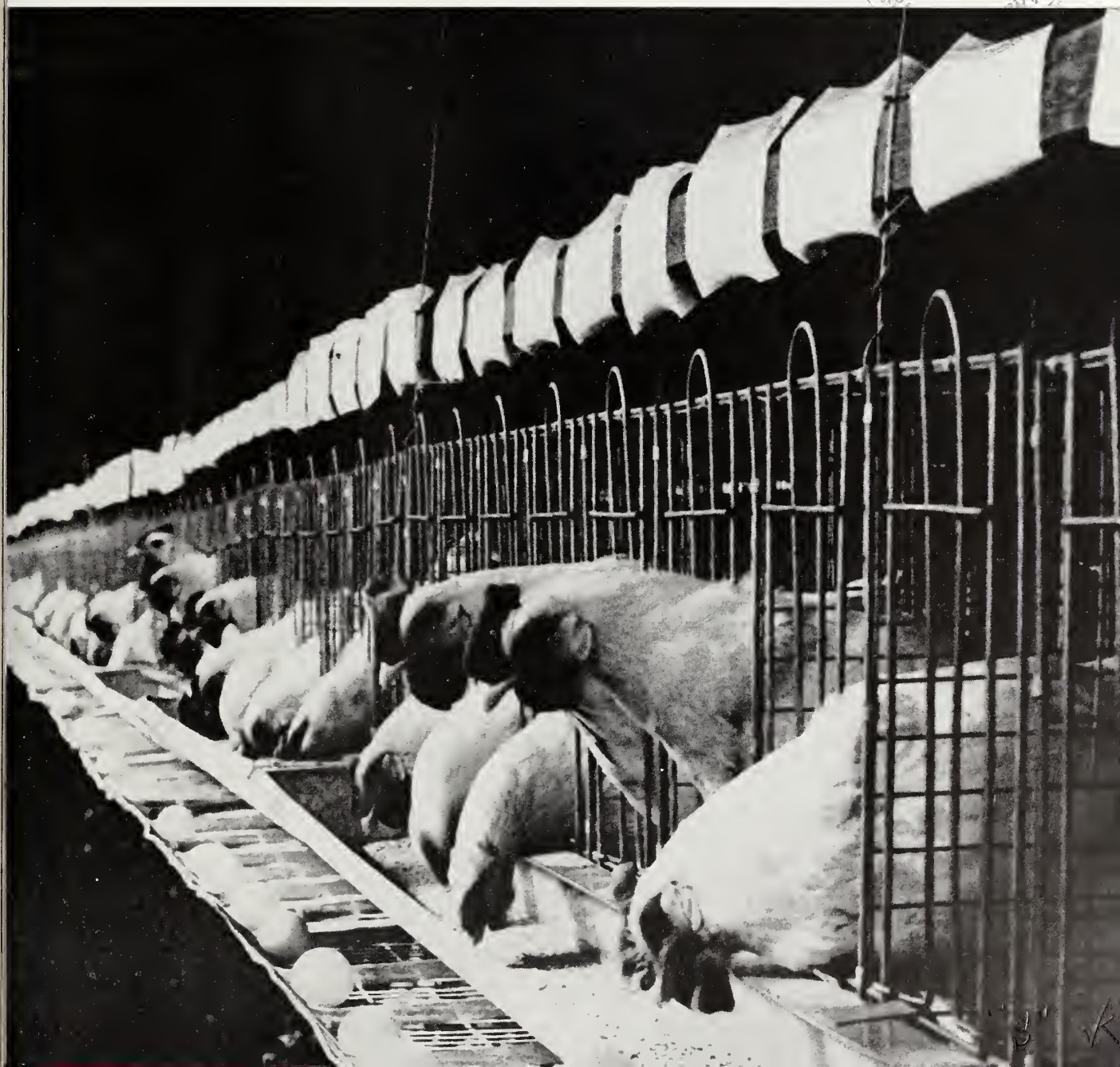
WHICH STRAIN FOR CAGE LAYING? Page 6



AGRICULTURAL
Research

September 1965/Vol. 14, No. 3

Controlling Pests

"One of the most important responsibilities of the Department is to develop and facilitate the use of methods and materials for the control of pests," Secretary Freeman said in a policy statement on pesticides issued earlier this year.

In so doing, the statement continues, "the Department has vital concern (1) for the health and well-being of people who use pesticides and those who use products protected by their use; and (2) for the protection of fish, wildlife, soil, air, and water from pesticide pollution."

The Congress supported this policy when it made funds available for the ARS Metabolism and Radiation Research Laboratory dedicated recently at Fargo, N. Dak. There, scientists are conducting basic research to learn exactly *how* plants, animals, and insects take up, store, break down, and eliminate chemicals. Information gained may lead to the development of new pesticides that will be effective in controlling pests—without creating hazards to man or to beneficial plants and animals.

The Fargo scientists are also exploring control techniques that do not rely on pesticides. For example, they are seeking new uses for the insect sterility technique, already applied so successfully against the screwworm throughout the South.

Month after month, this magazine has reported unique new methods of combating pests—with light, sound, low-volume sprays, attractants, repellents, and diseases of destructive insects and weeds. Some of these methods are proving very effective; others must undergo further testing.

The bacterium Bacillus *thuringiensis* is highly effective against certain caterpillars attacking tobacco, cotton, and vegetables. But what effect does this same bacterium (or a virus or fungus) have on beneficial insects, such as honeybees? (See page 8, this issue.)

Before any new pest control method can leave the laboratory, its effect on man, wildlife, and the environment must be firmly established.

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Editor: R. E. Enlow
Contributors to this issue:
R. J. Anzelmo, J. R. Deatherage, D. W. Goodman, M. B. Heppner, J. R. Nordquist, F. J. Parks, R. T. Prescott, J. M. Singer

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Orville L. Freeman, Secretary
U.S. Department of Agriculture

G. W. Irving, Jr., Administrator
Agricultural Research Service

HOGS — A CROP AT A TIME

By causing sows to come into heat all at one time, scientists synchronize breeding and farrowing

■ Can sows be brought into heat at the same time, thus permitting synchronized breeding and farrowing?

In tests at Beltsville, Md., 132 gilts and sows were given a synthetic drug in their ration, brought into heat simultaneously, and bred artificially. Of those continuing in the tests through farrowing, all gave birth to their young within a 3-day period.

The sows averaged 8 pigs per litter, about the same as control animals used for comparison, and length of gestation was normal. To date, the treatment had no apparent ill affect on any of the pigs, an important consideration in the tests.

ARS animal physiologist R. J. Gerrits is conducting the studies, using a compound called MATCH, a shortened version coined from the chemical name—1-a-methylallylthiocarbamoyl-2-methylthiocarbamoyl - hydrazine (I.C.I. 33,828). The compound, developed and patented in England, is now being examined by the Food and Drug Administration—a necessary step before it can be cleared for use by farmers.

Hog producers could easily administer the compound, Gerrits said, by mixing specified amounts into feed given to the female breeding herd. The females are kept on the fortified feed for 20 days. Five to seven days after they receive the last dose, the treated sows come into heat.

After making a preliminary report of his findings last year, Gerrits received inquiries from scientists and hog producers all over the world. They recognized that the new procedure could make possible the greatest advance in hog production since the development of antibiotics.

First, the compound could make artificial insemination practical in hog production. Artificial insemination has not increased in the hog industry, as it has in the dairy industry, because boar semen cannot be stored for more than a few days, and there has been no way to induce or delay heat in female hogs.

HOGS—A CROP AT A TIME (*Continued*)

Artificial insemination makes possible maximum use of boars with proved capacity to sire pigs that gain rapidly and efficiently and that yield high-quality lean meat. This should provide more lean pork to consumers without any increase in pork prices.

Second, producers could utilize equipment, buildings, and labor more efficiently if sows farrowed all at the same time, thus reducing the overhead cost per pig marketed.

Third, the use of the compound could help prevent disease cycles. Present continuous farrowing results in a buildup of diseases of very small pigs. If, however, litters were all the same age, the disease cycle would be minimized.

Fourth, hog producers could plan their yearly program so they would have a given number of pigs ready for market at specified times.

Fifth, use of the compound to synchronize heat periods would facilitate such basic research studies as determining the influence of the mother on the development of unborn young, which requires the transplanting of living embryos from one animal to another.☆

SQUASH × WILD GOURD = RESISTANCE AGAINST MILDEW

■ An ARS plant geneticist has developed several lines of squash with good resistance to powdery mildew fungus by crossing a wild gourd with commercial squash varieties. These lines, now being tested by plant breeders, could provide the stock needed to develop commercial squash varieties that resist powdery mildew.

T. W. Whitaker developed the lines at La Jolla, Calif., using the wild gourd species *Cucurbita lundelliana* as a source of resistance. The gourd is native to Southern Mexico and Northern Guatemala.

Even though the wild species is not immune to powdery mildew it does have considerable resistance, contrasting with the extreme susceptibility of all domestic *Cucurbita* species. The wild gourd crosses readily with two domestic squash species, *C. maxima* and *C. moschata*, although there is some loss in fertility.

In 1952, Whitaker crossed the wild species with the commercial variety Banana (*C. maxima*) followed by two crosses with Large Cheese (*C. moschata*). After four generations of selection and selfing, several relatively stable lines emerged with much more resistance to powdery mildew than the susceptible commercial varieties.

The lines are reasonably fertile and their vines are vigorous and prolific, according to the investigator. Although the quality of the flesh has not been tested, Whitaker points out that the flesh color and thickness and the shape of the fruit are acceptable when compared with commercial varieties Butternut and Large Cheese.☆

Animal husbandmen weigh several long-held theories in 5-year studies

All-Grain Ration—

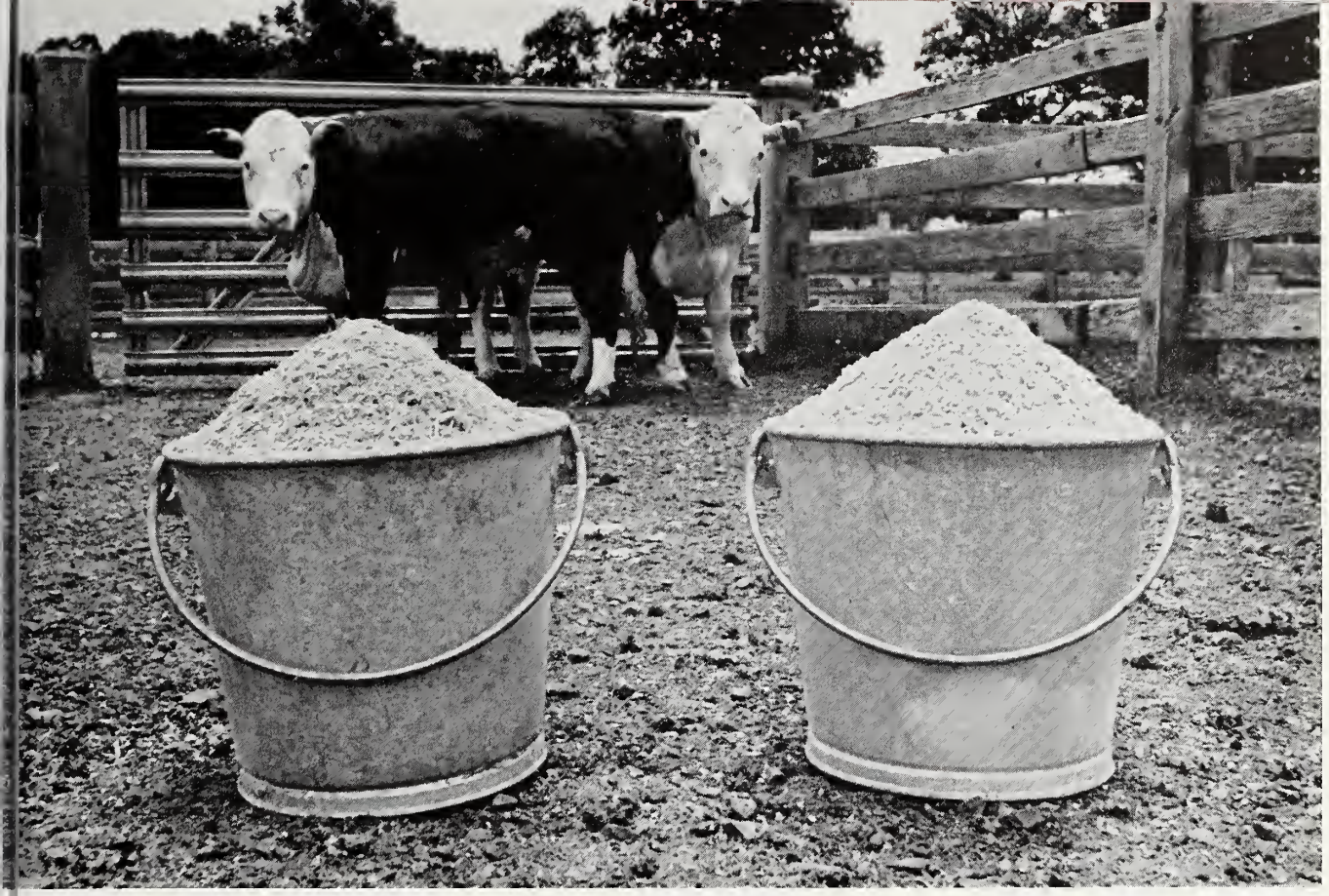
Boon or Bugaboo

■ All-concentrate finishing rations based on either corn or wheat have been successfully fed in trials at Beltsville, Md., involving more than 250 steers over the past 5 years.

The ARS trials, supported by studies at State Agricultural Experiment Stations, not only show practical ways to finish cattle but also challenge theories that have influenced cattle-feeding practices in the past:

1. That cattle require roughage for health and efficient growth.
2. That minerals found in hay must be added to finishing rations.
3. That vegetable proteins are superior to synthetic urea.
4. That wheat cannot be fed as the major source of carbohydrates.

Beltsville scientists R. R. Oltjen, R. E. Davis, and James Bond fed several lots of yearling steers an all-grain



Several lots of yearlings raised on an all-grain finishing ration (right) maintained good health, gained rapidly, converted feed efficiently, and produced carcasses of acceptable market quality. Other yearlings received the same concentrates plus 25 percent hay (left) and did equally well. The added roughage gave no advantage.

corn finishing ration for about 16 weeks to slaughter weights of 900 to 1,100 pounds. The steers maintained good health, gained rapidly, converted feed efficiently—and produced carcasses of acceptable market quality.

Earlier in the studies, the scientists found that cattle do not need the additional bulk or roughage usually fed. Two lots of yearlings were fed free choice on like rations of corn-plus-supplements except that half of the animals also received cobs ground and mixed into the ration for bulk. Cattle receiving the ration with cobs added ate just enough more to get the same amount of grain eaten by the group on the all-grain ration. Growth rate and carcass grades were similar.

The scientists knew that certain minerals usually obtained from hay are lacking in the high-grain rations, so they fed zinc or steamed bonemeal as supplements. Neither, however, gave any benefit. To further test the need of additional minerals, they added a buffering mixture of calcium and potassium carbonates and magnesium sulfate to the all-grain rations to obtain a favorable ruminal pH. This mineral combination (1) had little effect on gain and feed efficiency, (2) caused the only cases of bloat, and (3) lowered carcass quality an average of one-third of a grade.

Although vegetable protein supplements are traditional with cattle feeders, the Beltsville researchers found urea equal to soybean meal when measured by animal performance.

Wheat was substituted for corn in the finishing ration fed other groups of steers. Rate of gain and feed efficiency were reduced when wheat comprised more than 60 percent of the total ration. Cattle fed an all-corn ration gained 3.1 pounds daily, compared with 2.6 pounds for cattle fed an all-wheat ration. Although corn was a superior feed grain in these tests, wheat contains more protein and therefore requires less protein supplement. And wheat sometimes is cheaper, as was the case in 1964.

The Beltsville research also questions the viewpoint that all-concentrate feeding may be responsible for founder, kidney, and liver diseases, and bloat among feedlot cattle. None of the grain-fed steers had founder or kidney lesions. Only about 15 percent of the livers were condemned—far fewer than the 40 to 80 percent reported by some feeders. And except for occasional instances, bloat occurred only in steers fed buffers.☆

Poultrymen with caged layers should determine density level, then decide . . .

Which Strain For Cage Laying?

■ Once a poultry producer has decided how much room he will allow caged layers, he should buy the strain of laying hen that will adjust best to the allotted space.

ARS scientists at Athens, Ga., reached this conclusion after conducting a 280-day laying trial in which six strains of hens were housed at three density levels: One hen per cage; two per cage; or as a colony of five hens sharing two cages with the partition removed (2½ per cage).

Geneticist R. E. Cook, leader of the group doing the investigation, says that strains housed at different densities varied widely in production per hen and in mortality. On factors other than eggs per hen and mortality, the researchers noted no strain differences. Egg-quality factors, such as blood spots or egg weight, appeared unrelated to strain or space per bird.

The six strains of hens used in the test came from commercial hatcheries. They were housed at 21 weeks of age in 10- by 18-inch cages. so that individual hens had available 1¼ sq. ft., ⅝ sq. ft., or ½ sq. ft. of cage space.

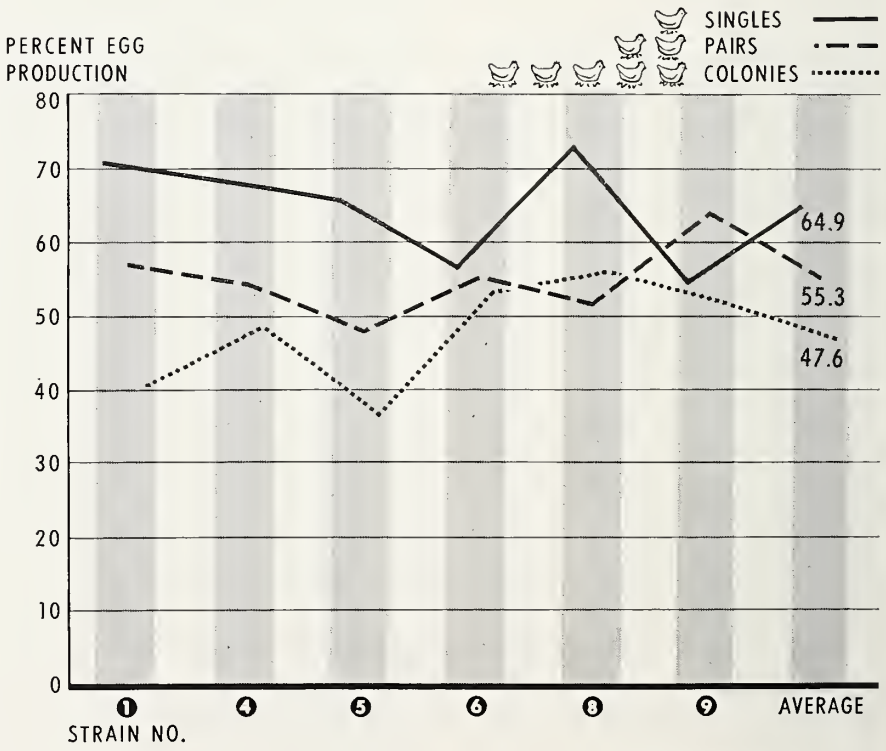
Strain 9, the top performer in pairs, averaged 6½ more eggs per hundred hens each day than the nearest competitor (strain 1). It bested the average of all paired birds (regardless of strain) by 9 eggs per hundred per day and the bottom strain (number 5) by 16 eggs.

The pairs from strain 9 equaled or exceeded eggs per bird produced by three strains caged singly, including birds from their own strain. Two strains caged as pairs, however, had poor records when they were compared with singles: Strain 5 produced one-third fewer eggs per hen and strain 8, one-fifth fewer.

In colonies, the situation differed again. Number 8 was the only strain that laid more eggs in colonies than in pairs, but the difference amounted to only about four eggs per hundred hens per day. In strain 1, production of colonies averaged almost one-third below that of pairs.

All strains laid more as singles than as colonies. The difference in daily production per hundred hens ranged from two fewer eggs in strain 9 to 32 eggs less in strain 1.

If a poultryman had to pick the one



Egg production of the six strains varied greatly at all three levels of density—as is shown in this graph. Results are based on the production per hen—not per cage—to emphasize strain differences.

or two top strains from those in the ARS study, he would quickly conclude that some strains seemed particularly adapted to one level of density, but not to another. For example, strain 9 rated high with two birds per cage; strain 6 did well with colonies of five. But as singles, birds from strains 6 and 9 proved to be the poorest producers.

Why this difference? "Some strains just proved to be a little tougher than the others," Cook explains. "Fewer birds from the more persistent strains died. We didn't lose any strain 6 birds from the pairs and only 8.6 percent of strain 6 birds from the colonies. In strain 9, only 7.1 percent of the pairs died. Colonies of strain 5 birds, on the other hand, had a mortality of 37.1 percent."

● A look at the Athens study without stressing strain differences reveals that average egg yield increased almost three-fourths when occupancy per cage was doubled. Egg quality, meanwhile, stayed the same. Therefore, a producer can increase his income by putting two birds into a cage instead of one, even though production per bird decreases.

● This differs from the situation a half dozen years ago, when ARS did not recommend crowding birds. Today, however, investment in housing and equipment is greater, profit margins are smaller, and management has improved to change the outlook on limited crowding.

● Yet, crowding to an average of 2½ birds per cage was of little additional benefit in the trial and would raise a poultryman's income only under superior management. On the average, production of colonies was only slightly greater per cage of 2½ birds than per cage of pairs—not nearly enough increase to pay for the additional half bird and her feed.☆

It worked against screwworms and Mexican fruitflies; now the male sterility technique looks promising against . . .

PINK BOLLWORMS

■ Chemical sterilization looks promising as a method of controlling or eradicating the pink bollworm, laboratory investigations have shown.

ARS scientists are studying chemical sterilants to find ways to sexually sterilize insects without otherwise affecting their vigor. Their objective is to mass rear insects and release them to control or eradicate an insect species by preventing reproduction.

The practical value of the sterility technique was shown in 1958–59 when the screwworm was eradicated in the Southeast by releasing screwworm flies that had been sterilized by cobalt radiation. Its value was verified further last year when millions of Mexican fruitflies, sterilized with a chemical, were released along the Mexico-California border. This prevented the fruitfly from becoming established in California.

ARS entomologists M. T. Ouye, H. M. Graham, and D. F. Martin, and research technician R. S. Garcia, cooperated with the Texas Agricultural Experiment Station at Brownsville in the pink bollworm sterilization tests. They used metepa to sterilize the male and female moths.

By far the most efficient treatment tried by the researchers was direct application of the chemosterilant to males at a rate of one two-millionth of an ounce of metepa per male. This gave effective sterilization with only a slight reduction in mating frequency.

Only 4 eggs hatched out of 13,622 eggs laid by females mated with sterilized males, and later tests showed that these 4 probably would not have developed into normal adults. Egg laying by treated females mated to untreated males was reduced considerably, but 6 percent of the eggs hatched.

The scientists also sterilized males by exposing them to metepa residues. Adult males were confined for 15 minutes in jars where the residue on the surface of the glass was less than one two-hundred thousandth of an ounce per square inch. Only 5 eggs hatched out of the 7,416 laid by females that mated with these males. When the researchers increased exposure time to an hour, only 2 eggs hatched out of 7,411. Exposure to residues reduced the life span of the pink bollworms—the longer the exposure the shorter the life of the insect.

The scientists say the value of sterile pink bollworm moths for controlling or eliminating low level populations, or the beginnings of potential infestations, will require further field evaluation.☆

What Effect Do Insect Pathogens

For Other Articles, See . . .

- Virus May Be Our Ally, AGR. RES., June 1959, p. 15
- Learning How Viruses Develop. AGR. RES., March 1962, p. 3
- Living Insecticides. AGR. RES., December 1963, p. 3
- A Microbial War On Insects. AGR. RES., September 1964. p. 3
- Natural Insecticides, AGR. RES., November 1964, p. 8

Before organisms can be recommended for use against insect pests, scientists must know how they will affect friendly insects

■ Spray a field with a virus or another organism that kills a particular insect pest. and what happens to such beneficial insects as honeybees? With growing interest in insect pathogens as natural insecticides, this question takes on added importance for researcher and farmer alike.

To learn part of the answer, ARS insect pathologist G. E. Cantwell and microbiologist A. S. Michael, are feeding colonies of bees at Beltsville, Md., on diets containing various concentrations of insect pathogens.

Specifically, the bees are ingesting two fractions of the bacterium *Bacillus thuringiensis* (exotoxin and crystal toxin), which are recommended for use on certain caterpillars attacking tobacco, cotton, cole crops, and vegetables; the fungus *Beauveria bassiana*, which is nonspecific in its attack on insects; and the nuclear polyhedrosis virus, which attacks the corn earworm and the tobacco budworm.

Bees were selected for the tests because of their economic importance, and because as social insects they are particularly susceptible to disease. Also as a result of this social behavior, it is possible that an organism that does not visibly affect individual bees may harm the colony. Scientists wonder, for instance, whether certain pathogens might affect honey or wax production, or egg laying by the queen, without killing the bees or harming them in other ways. Only studies of bee colonies can provide such data.

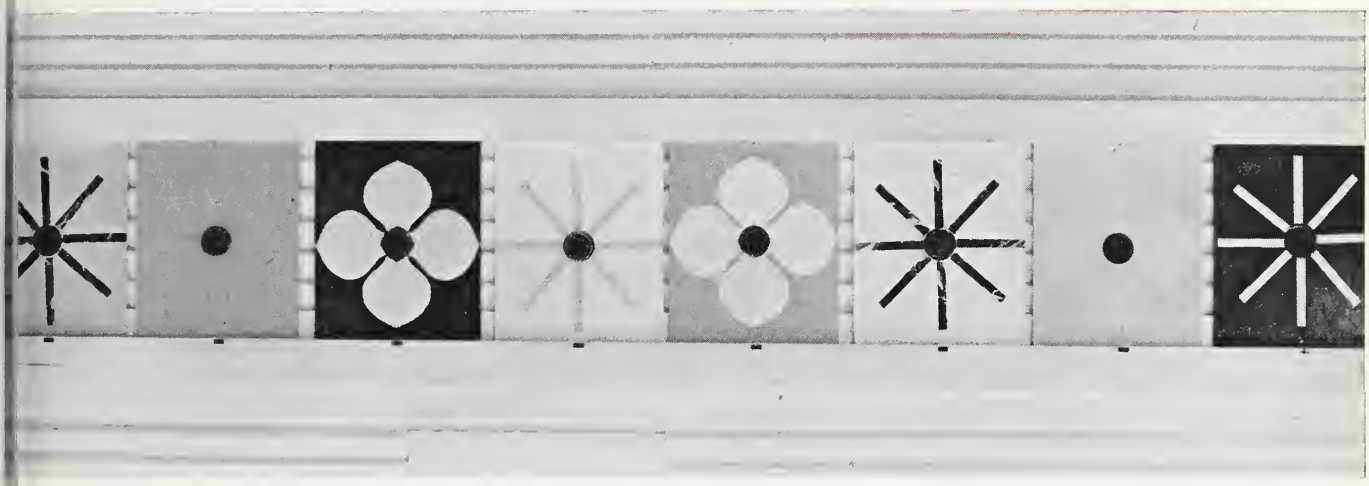
The scientists believe the current tests will add support to previous studies and observations. Earlier research found, for example, that the fungus *B. bassiana* was harmful to honeybees. This phase of the research is being continued to obtain more conclusive evidence about the effects of fungus on honeybees and undoubtedly will add knowledge about the effects of other pathogenic fungi on pollinating insects.

Investigations conducted by Cantwell last year showed that one of the bacterial exotoxins, fatal to flies, will also kill bees—but only when administered at dosages higher than any used in field applications against insect pests. In the current tests, the two scientists are feeding exotoxin to 12 colonies of bees at various concentrations above and below the minimum lethal dose, hoping to detect the effects of sublethal doses on the colonies. Six colonies will receive crystal toxin in their diets.

Finally, a virus widely believed to affect the corn earworm and closely related species is being fed to four colonies of bees. If it proves harmless to the colonies, researchers will have added more evidence to that already amassed indicating that viruses are highly specific control agents.☆

Two of the pathogens fed to honeybees were—TOP LEFT: Bacillus thuringiensis *crystal, shown as an electron micrograph of a carbon replica; LEFT: Polyhedron of the corn earworm virus, shown magnified many times as cross sectional plaster model, contains rod-shaped virus particles.*

Have On Honeybees?



TOP—Bees leaving colonies exit through openings with combinations of specific colors and designs, no two of which are alike. On returning, the bees recognize the patterns and colors, and find their way back to the proper hive. BOTTOM LEFT—Microbiologist A. C. Michael, research leader, keeps an accurate account of the bee colony being fed the pathogens. The information is needed to determine whether or not an organism harms individual bees or the colony. BOTTOM RIGHT—Pathologist G. E. Cantwell prepares a diet containing insect pathogen material to determine its effects on honeybees.

Pasteurizing Egg White

Scientists perfect method that does not lower whipping quality

■ Commercial egg white—used in cakes, meringues, and other foods—can now be pasteurized without damaging the proteins or significantly lowering the whipping quality or cake volume.

Regulations are Amended

Development of the pasteurization process has led the Department to amend its regulations on grading and inspecting egg products.

The amended regulations, administered by the Consumer and Marketing Administration, now require that all egg products (except whites) produced under inspection be pasteurized—or analyzed if equipment for pasteurization is not available. Egg whites shall either be pasteurized or analyzed for the presence of *Salmonella*. Plants not equipped for pasteurization must arrange for pasteurization of those whites, whole eggs, and yolks found to have the *Salmonella* organism.

Effective January 1, 1966, pasteurization will be mandatory for all egg products except whites. Effective June 1, 1966, egg white products must also be pasteurized.

The new pasteurizing process already has been tested on a large scale and is expected to expand both domestic and foreign markets for liquid, frozen, and dried egg whites. U.S. production of commercial egg whites (liquid basis) is now 200 million pounds annually.

ARS chemists Hans Lineweaver and F. E. Cunningham developed the process at the Western utilization research laboratory, Albany, Calif. It involves stabilizing liquid egg white to withstand the heat of pasteurization, which serves as a safeguard against bacteria, especially *Salmonella* organisms. These organisms can cause food poisoning characterized by nausea and fever.

Although liquid egg yolks and whole eggs have been pasteurized for many years, adequate pasteurization of egg white alone has not been possible because the necessary heat level damaged the proteins. This damage caused smaller cake volumes and loss of whipping quality in meringue.

Lineweaver and Cunningham have devised a way to stabilize the four heat-susceptible proteins of egg white. An acid, preferably lactic acid, is used to lower the pH of white from its normal 9.0 to 6.8. This protects the three main proteins—lysozyme, ovomucoid, and ovalbumin. A fourth protein, conalbumin, requires a metal salt, preferably aluminum sulfate, for stabilization.

(The pasteurization process applies principles that were established in basic research on the isolated individual proteins. The research proved that proteins in the egg white react in the same way as they do separately—as pure isolated proteins in solution. The studies on proteins also showed that whole egg withstands pasteurization because it has a neutral pH, and the yolk contains enough iron to stabilize conalbumin.)

In preparing the stabilizing solution, the chemists mix 1 ounce of aluminum sulfate to 1 pound of 25-percent lactic acid. Only 6.5 pounds of this solution are required for each 1,000 pounds of egg white. Triethyl citrate or triacetin may be included as a whipping aid, if desired. The entire mixture is flash heated to 140° F. and held for 3½ to 4 minutes—the heat and time required to insure adequate pasteurization.

The scientists point out that in cake formulas containing pasteurized white, cream of tartar can be reduced about 20 percent, since lactic acid has already been added.

The researchers are continuing their studies for further improvements and simplifications.☆

These angelfood cakes are identical in taste, volume, and quality. One (right), however, was made with pasteurized white; the other with unpasteurized white.

BLANKETING PONDS

. . . with a molecular film that cuts evaporative water loss by 40 percent

■ Nearly 5 trillion gallons of water evaporate annually from small farm ponds and reservoirs in the 17 western States. That's enough water to supply all of the households in the United States for 1 year—or all the cattle in those same western States for over 20 years.

This water loss can be greatly reduced, ARS studies at the U.S. Water Conservation Laboratory, Tempe, Ariz., have shown. Scientists lowered evaporation from experimental tanks, as much as 40 percent, by placing a molecular film of evaporation retardant on the water surface.

The scientists used alkanol, a waxy solid commonly used in lipstick, as the retardant, applying it to water after it had been mixed with a water soluble carrying agent (matrix). Various alkanol-matrix mixtures were tested at the laboratory on tanks approximately 9 feet in diameter and 3 feet deep.

(Alkanol molecules are long and slender—one end is attracted to water, the other is repelled. When they are spread on water, they stand on end like a bundle of pencils. If enough molecules are present to form a film, evaporation is retarded because the water must—in order to escape—pass through narrow openings between the molecules.)

Although researchers have long known that alkanol will retard evaporation, practical application was delayed because a carrying agent was needed to dispense and maintain the film. The matrix dissolves and releases alkanol at a continuous rate.

The scientists say that low-cost sugar sirups—molasses, for instance—may prove the most economical matrices. Besides sugar sirups, they tested gum tragacanth and hydroxyethyl cellulose.

In one test, a 29-percent alkanol was mixed with a sucrose-sugar matrix and placed in a test tube. This tube was then suspended $\frac{3}{8}$ inch below the water surface.

Over a 2-week period, the dissolving matrix released alkanol at a rate of about $\frac{1}{2}$ gram per day. This treatment held evaporation to 4.4 gallons per day, about 40 percent below that evaporating from an untreated check tank, which lost slightly more than 11 gallons per day.

But is it practical? Laboratory director L. E. Myers believes it is—for small ponds. More research and more field testing are needed, however, to determine the release rates.

Myers points out that wind, which causes a high rate of evaporation, breaks up the alkanol film at a time when it is needed most. Consequently, the release rate on a small pond must be such that it will maintain a film in normal wind and recover quickly from a high wind.

Three ways have been found to control the rate of release:

- By controlling the percentage of alkanol in a mixture. The greater the percentage, the faster alkanol is released to form a film.
- By controlling the area of mixture exposed to water. The larger the area of exposed mixture, the faster the matrix dissolves and releases the alkanol.
- By the selection of a matrix. Different matrices dissolve at different rates. Hydroxyethyl cellulose, for instance, dissolves faster than gum tragacanth. The rate at which the sugar sirup matrix dissolved varied widely, depending upon the concentration of sugar and the particle size of the alkanol.

Practical and effective release methods have not yet been developed for large bodies of water. Reservoirs that supply big western cities, for example, lose about $3\frac{1}{2}$ times more water to evaporation than small ponds and reservoirs—largely because they are disturbed more by wind.

An alkanol-release rate that would maintain a film on a large reservoir during windy weather would be too high during a calm. Myers points out, however, that it might be possible during windy periods for an airplane to drop containers of supplementary alkanol-matrix mixture for quick release in large reservoirs.☆

TESTING BOLL WEEVIL VISION

Sight studies: Part of search for new control methods

■ ARS and Texas scientists are studying boll weevils in an attempt to discover how well they discriminate between various intensities of color and light.

The tests were made by ARS agricultural engineer J. P. Hollingsworth and Texas A & M physicists D. L. Mordue and O. D. Sittler, who are seeking ways of using light to attract or repel boll weevils. Their work is part of a broad effort by ARS to develop new and more effective methods of insect control.

The studies so far indicate that boll weevils detect radiation in the same spectral region as humans, but they also detect ultraviolet rays, which are not visible to humans. The tests indicate, as well, that both male and female boll weevils may possess a type of color vision.

The researchers feel that the instrumentation and techniques used in this study may be applied with equal success to similar studies with other insects. Here, briefly is the procedure they followed:

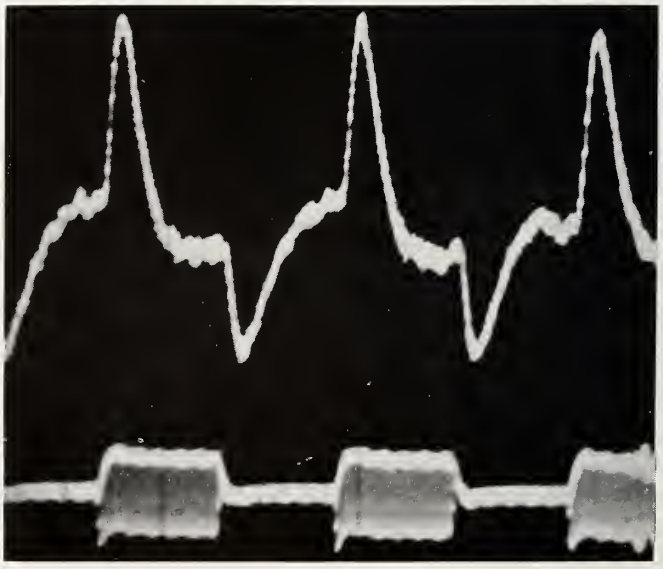
Ten boll weevils—five male and five female—were selected and examined individually. Each was anesthetized with carbon dioxide, attached to a cork platform with tacky wax, and placed inside a metal enclosure. Then a steel wire probe, sharpened by acid and attached to a crystal detector, was placed on the corneal surface of the insect's eye. Another was inserted into its snout.

Upon exposure to various colors of light, the eye generated an electrical signal which is believed to originate in the retina. This signal was received through the probes, amplified, and recorded in the laboratory as a curve (or electroretinogram) on an oscilloscope. By noting which intensities of specific colors of light produced a constant signal, the scientists were able to determine which colors were most easily detected by the insect.

Most of these readings were begun in the afternoon or evening of one day and concluded in the morning of the following day. Some were taken continuously for as long as 3 days after a probe was positioned on the corneal surface.☆

Physicist D. L. Mordue adjusts a probe to the retina of a weevil's eye before stimulating the insect with a light beam.

LEFT—A steel wire probe sharpened by acid and attached to a crystal detector takes electrical signals from the eye of a boll weevil. Magnification is more than 100 times. RIGHT—Signals from a boll weevil's eye are received through probes, amplified, and recorded in the laboratory. When exposed to various colors of light, the eye generates an electrical signal (top) believed to have originated in the retina. Photocell signals (below) indicate when lights are on.



What Causes Pink Eye in Cattle?

Using bacterium plus light, scientists produce the disease in laboratory studies

■ A combination of bright sunlight and the bacterium, *Moraxella bovis*, probably causes pink-eye in cattle, say ARS scientists who produced the disease under controlled conditions at the National Animal Disease Laboratory, Ames, Iowa.

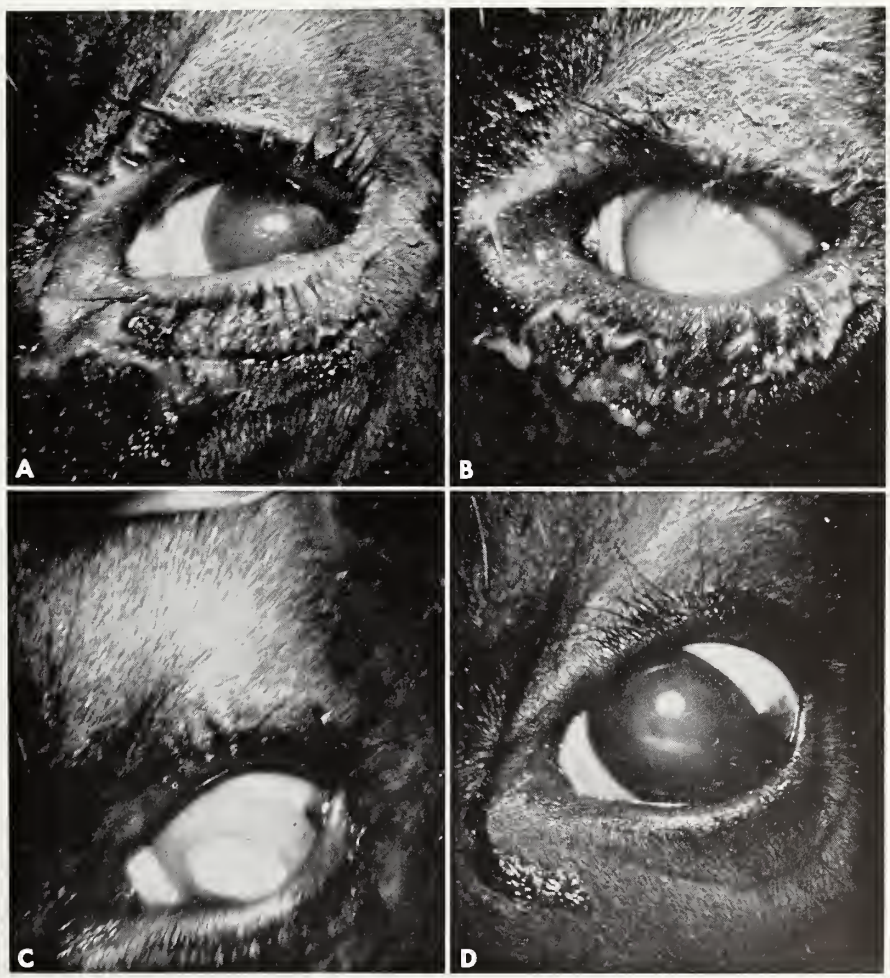
Pink-eye is known scientifically as infectious keratitis and was first recognized as a contagious cattle disease in 1889. Common in all areas of the world, the disease is most frequent in the summer but may occur in any season.

The disease affects only the eyes of cattle, causing pain, temporary loss of sight, and ulcers. In severe cases, the eyeball may be destroyed. Because cattle cannot find their way about pastures to graze, they give less milk and often injure themselves by falling into ditches, or waterholes.

To study the disease, D. E. Hughes, G. W. Pugh, and T. J. McDonald isolated three groups of healthy cattle in air filtered, windowless rooms. The eyes of one group were inoculated with pure cultures of *M. bovis*, the bacterium often found in eyes of cattle suffering from pink-eye; a second group was exposed to sunlamps for various lengths of time; and a third group received a combination of the bacteria and light.

The scientists found that *M. bovis* inoculation alone caused only a mild disease, while *M. bovis* plus daily doses of light caused severe cases of keratitis. Excessive doses of light also caused eye injury.

The scientists plan further studies of the interaction of light and *M. bovis*, using smaller doses of each. They will also explore the possible role of other agents isolated from field cases of keratitis—in their search for ways to cure or prevent this disease.☆



The effects of the bacterium and light can be seen in this series of photographs, taken at fixed times after infection. (A) At 4 days, a marked change is seen, although secretion was above normal; (B) at 8 days, a dark band has formed at the outer edge of the cornea, and the remainder of the cornea is more opaque; (C) at 19 days, the width of the band has greatly increased and the central portion of the cornea is much smaller; (D) after 92 days, the cornea has begun to heal, and the pupil can be seen. The central dense scar in most cases is permanent. (The spot of light in photos A, B, and D is reflected from the flash camera.)

DATE HARVESTING: ALL BY MACHINE IN 1967

ARS—California engineers work with industry to mechanize picking

■ Within the next 2 years, nearly all of the Nation's crop of California dates is expected to be harvested and handled mechanically.

This achievement, if realized, will be due largely to the efforts of agricultural engineers of ARS and the University of California Agricultural Experiment Station at Davis. Working cooperatively with the date industry, these scientists have successfully concluded studies and testing of equipment and methods for mechanically harvesting and handling dates.

When G. K. Brown of ARS and R. M. Perkins of California began the work in 1961, the 40,000,000-pound date crop was picked almost entirely by hand. Using equipment and methods developed in the Brown and Perkins study (AGR. RES., March 1964, p. 7), date growers mechanized about one-third (12,000,000 pounds) of last year's harvesting operations. The man-hours required for harvesting this part of the crop were reduced about 75 percent.

Up to three-quarters of the crop should be harvested mechanically next year, followed by virtually complete mechanization 2 years hence. At that time, the researchers estimate, total harvesting costs should be about $300,000 below the current level.☆

FRUIT GRAFTING: IT'S IN THE BAG

New method substitutes polyethylene bag for greenhouse or humidity chamber

■ An ARS plant pathologist has developed a simple grafting technique that should prove useful to scientists who graft citrus fruits on to small potted seedlings. The new method substitutes a polyethylene bag for the greenhouse or humidity chamber.

The technique, developed by E. O. Olson, has been used successfully to graft young grapefruit, mandarin, and citrangequat fruits to sour orange and *Severina buxifolia* (Chinese box-orange) seedlings. Trials were conducted at Weslaco, Tex., in cooperation with the Texas Agricultural Experiment Station.

Scientists graft a twig bearing a young fruit to a small seedling to study the influence of leaves of the seedling on fruit development and composition, and to study color development as the fruit grows. The procedure is also useful in the study of viruses and virus diseases.

Olson points out that the key to successful grafting with the polyethylene bag method is to enclose 8 to 12 inches of the leafy seedling in the bag with the graft. The transpiring leaves add moisture to the air around the fruit and provide the high humidity needed to prevent evaporation from the developing fruit. Trials by Olson to graft decapitated seedlings (shoot removed) under polyethylene bags were unsuccessful.

Successful citrus fruit grafts can be made on decapitated seedlings, but the technique involves enclosing the seedling and the fruit graft in a greenhouse or in a high-humidity glass chamber.☆

AGRISEARCH NOTES

Thin egg shells: Too much water?

Thin shells on market eggs don't come about because chickens drink more water than usual, according to ARS research. Since hens do drink extra water in hot weather and egg shells get thinner at the same time, a connection could be assumed.

One investigator backed up this suspicion with a plausible assumption. He knew that when a chicken is injected with a diuretic (a substance that causes the body to produce an unusual amount of urine), the bird lays eggs with thinner shells. The investigator postulated that production of urine requires calcium, as does eggshell formation. In theory, more calcium going into the production of urine means less calcium available for egg shells.

ARS poultry physiologists pursued the "urine-competition" question from another angle, however. They reasoned from the established knowledge that when the posterior lobe of the pituitary gland is removed from a chicken, the bird drinks large amounts of water. It therefore produces three to eight times more urine than before the operation. If excess urine did tie up calcium, a chicken without the lobe should lay eggs with thin shells.

Using a relatively simple surgical technique devised by ARS, the physiologists operated on hens and examined eggs laid while the chickens drank the large amounts of water. The results: Shells were normal, no thinner than those produced by control chickens—those that did not undergo the simple surgical operation.

Although the scientists as yet do not know what causes thinner egg shells in hot weather, they have disproved the "urine-competition" idea.

Designed: A portable rainmaker

A portable rain machine that can be pulled from one field test plot to another, by hand or with a small tractor, has been developed by an ARS agricultural engineer.

Erosion-control researchers use rain machines in evaluating rainfall runoff and soil loss on test plots that have been mulched or planted to crops. Most rain machines are complex and comparatively expensive; they require a trained crew to operate and are usually cumbersome to move.

N. P. Swanson developed and mobilized the rain machine, adapting it from a commercial rotating-boom sprinkler. The Nebraska Agricultural Experiment Station cooperated in the work which was conducted at Lincoln.

Built on a trailer, the machine has 10 rotating booms that look like wheel spokes radiating from a hub. The booms are attached to an upright, axle-like pipe with irrigation couplers.

Water flows up through the axle and out the booms to calibrated spray nozzles. Each boom has three nozzles, and each nozzle is controlled with a separate valve. When all nozzles are open, the machine rains 5 inches per hour.

A small air-cooled gasoline engine rotates the axle and booms so that the nozzles simulate continuous and even rainfall.

Once the water supply is disconnected, the machine can be moved from one test plot to another in the same field in less than 30 minutes.

This portable rainfall machine can be moved from one test plot to another without disturbing stationary measuring equipment or plots. Its 10 rotating booms produce a continuous and even fall of water at adjustable rates.

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AGRISEARCH NOTES

Volunteer plants reduce seed purity

Production of red clover seed from a given planting should be limited to 1 year when the goal is 100 percent varietal purity.

This conclusion was reached by ARS agronomist P. E. Dade in studies on the survival of "volunteer" plants in red clover seed fields at Prosser, Wash. The research was cooperative with the Washington Agricultural Experiment Stations.

Under normal management conditions, seed lost during harvest and left to produce volunteer plants exceeds the original seeding rate. As a result, volunteer plants produce seed that becomes mixed with and contaminates seed of plants from the original sowing.

Volunteer plants represent advanced generations that may differ from the pure variety. If a large number of these volunteer plants, capable of producing pollen and seed, are growing in a commercial seed field, they can alter the identity and purity of a red clover variety.

To study the survival of volunteer plants, Dade broadcast and row planted a strain of red clover that lacks the normal crescent leaf marking. The plantings were made on plots that were free of red clover seed. These plots were mowed the first season before seed matured to prevent shattering of seed from the original plants. Then at normal harvest time, seed of a leaf-marked variety was broadcast over all plots to represent seed shattered during harvest operations.

By the second and third crop years, Dade found that volunteer plants—the leaf-marked variety—comprised a significant part of the total plant population. The percentage of volunteer plants in rows was nearly as high as in broadcast stands and in some plots, volunteer plants were producing up to 50 percent of the seed harvested by the third year.

Mass producing boll weevils

New techniques for producing and collecting boll weevil eggs are helping to cut costs and speed mass rearing of the weevils for use in research on new control methods.

Unlike some insects, which lay great numbers of eggs in a short period, boll weevil females lay only a few eggs a day over a 4- to 6-week span. Until now, producing and collecting these eggs have cost about a cent each.

ARS entomologist R. T. Gast, working with the Mississippi Agricultural Experiment Station, has developed techniques that lower the cost to a cent per *hundred* eggs—a considerable saving in view of the millions of weevils needed in testing male sterility, insect pathogens, and other new methods of controlling this destructive cotton pest.

Gast developed the techniques by improving several steps in the rearing process. First he redesigned the cages in which the weevil females lay their eggs. This boosted egg production 50 percent. He next devised a way to mass produce up to 11,000 diet pellets (substitutes for cotton squares) per man hour. Since the pellets were then readily available, and much

cheaper, more pellets and weevils could be used. This increased egg output still more. And the ready availability of pellets made it feasible to change them in the cages twice a day, which increased egg production another 50 percent.

Finally, Gast's methods allow the researchers to use only younger, higher egg-laying females (1 to 15 days old) for egg production. The older insects (15 to 30 days old) can be used in producing pathogen.

Our mistake—It's the same insect

The June 1965 issue of AGRICULTURAL RESEARCH carried an article on "Sesame . . . Attacked by tobacco budworms and corn earworms." This article incorrectly cited the cotton bollworm and the corn earworm as being different insects.

They are the same—*Heliothis zea* Boddie—differing only in their common names, which are determined by the crop they are attacking at the time.

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